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8. *The Principle of the "Indestructibility of Matter"* (*i. e., of Mass*)

"Numerous investigations have shown that neither by physical change of a substance, as, for example, by pressure, heating, magnetization, etc., nor by chemical decomposition, does there occur a variation of its mass as measured by the attraction of the earth."[17] In fact, the whole atomic theory of chemistry is a reduction of apparently diverse facts to terms of ultimate permanent units. This is on a par with what we found in physics, as to conservation of momentum. From the point of view of a series of instants or short periods in time, the unchangeable character of mass appears as a process whose logical structure is the same as that of the series describing uniform motion, inertia, etc.

The principle of the conservation of energy seems obviously to come under the same rule. It is, however, so broad and general and, where formally stated, so lacking in concrete detail that by itself it gives but a faint idea of the operation of causation; hence we content ourselves with this brief mention of it.

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REGULATION IN BEHAVIOR

SEVERAL years ago there appeared in *Nature* an account of a statistical inquiry into sex determination. The results indicated that children born to young mothers were predominantly girls and that those born to old mothers were predominantly boys. Whether this hypothesis has been borne out by further results I do not know, but, assuming it to be a law, it is an example of what has been called regulation in behavior. The purpose which such a process serves is clear. When there is a shortage of women in a community girls are likely to marry when very young, due to the increased opportunity afforded them on account of the under-supply of more mature women. If such marriages result in a number of female infants greater than the normal expectation, the balance between supply and demand is thereby reestablished. A similar compensation is had when, in a society where females predominate, and hence are not married so early in life, male offspring are in excess.

The world is full of instances of this sort. Organisms utilize the very difficulties they encounter in order to bring about the removal of these difficulties. Their make-up insures this regulation. They do not depend on outside guidance to carry them through adverse situations. The adverse situations in combination with an organism

[17] W. Nernst, "Theoretical Chemistry," Eng. tr., page 4.

are self-eliminating. Of course this is not always true for the individual, but the social group, which is the larger organism, survives because the procreation of its parts is as rapid as their destruction.

We often so construct a piece of machinery that this principle of auto-adjustment holds in its behavior. This is done so that we may not have to manipulate it and direct it to any great extent. The floating ball disconnects the circuit and stops the pump when the tank is full. The pendulum swings to one side and releases the air pressure which tilts the wing tip of the aeroplane when a gust of wind causes it to pitch or roll, and this restores equilibrium. The electric sterilizer is supplied with a soft metal plug which melts off and releases a spring, so breaking the circuit, when the water is exhausted. Otherwise the rheostat would be burned out. But now the heat prevents itself from being dangerous. A general statement of these and other forms of regulation might be valuable. It might indeed serve as a rule of thumb for inventors.

Bancroft[1] gives many excellent examples of regulatory behavior as illustrating his "universal law." This law is that "a system tends to change so as to minimize an external disturbance." Some of the cases he notes are:

The readjustment of prices through supply and demand.

Tears caused by and discharging an irritating substance from the eye.

A splinter causing its own sloughing out.

In chemistry, the occasional prevention of further reaction by some reaction products.

An insult causing a response which may prevent further insult.

The bending of trees to spill the wind.

It is certainly tautologous to say that organisms behave along lines of least resistance, for our only definition of least resistance is the resistance that a system is first to overcome. But any suspicion that the statement of Bancroft's law falls short in a like way of being a synthetic judgment, is removed after he has clarified it by illustration and comment.

Adaptation of a group of animals or plants *by selection* is a case of regulation if we regard the group as an organism. The capacity for all the responses is not resident in all the individual animals or plants, but is distributed among the parts (individuals) of the entire organism (group). The existence of the organism is maintained along with the life of those parts which respond adaptively to the present condition, notwithstanding the death of those parts which are not adjusted so to respond. This is shown in the adaptation of wheat to climate. A bushel of late ripening wheat will contain some grains of early ripening wheat. Planted under certain conditions, these latter alone will mature, but they will serve as seed for the next crop, which will inherit their characteristics for the most part, and which will be almost entirely early ripening wheat.

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[1] Bancroft, W. D., "A Universal Law," *Jour. Am. Chem. Soc.*, XXXIII., No. 2, February, 1911.

When an apparently new structural adaptation is developed in an organism by a set of new conditions, the presumption is that the organism's capacity for this change of structure was previously resident in the organism, and not that the change was wholly caused by the new condition. The condition was the necessary factor which had to be added to the organism's potential capacity, in order that the adaptation should result. An organism may in this way be so adjusted as to respond adaptively to any one of a number of possible conditions which may be mutually exclusive. So when one response is realized, the others may be latent. This is shown by the substitution of hair for wool in the coat of a sheep that is taken to a warmer climate. In the domain of behavior a similar rule is obvious. Here a given stimulus calls forth a particular reaction which is especially fitted to the situation.

THE VITAL MANIFOLD

Organisms living in an environment of changing conditions are, for the most part, constantly readjusting themselves to the change. They avoid bad conditions and seek better. Or, when an unfavorable condition can not be avoided, a change takes place in their structure which makes it possible for them to live in that condition. If, when in a certain medium some metabolic change takes place in them, which to be set right demands some other medium, they seek out that other medium either by trial and error reactions or, following certain clues present in their surroundings, by some specially appropriate instinctive or habitual reaction. If we admit that such processes are regulatory, we have made a beginning towards defining regulation. We may further say that it is characteristic of organisms having a certain structure. It is the result of the interaction of such organisms and their media. The organism and the media constitute a manifold which, though constantly operating, so functions as to prevent disintegration of the organism. The life-long stability of arrangement possessed by the organism and its offspring further differentiates it from the media and makes most significant the distinction between biology and the inorganic sciences. The field of the science of animal behavior of which the processes in such a manifold constitute the data, is in part hardly to be distinguished from some of the subject-matter of dynamic biology. The former science, however, always classifies these processes on the basis of the *regulation* which they display.

NEGATIVE REGULATION

Regulation occurs when any process in the manifold which reduces the stability of the organism results in such a change, either in the media (through the organism's migration or otherwise) or in the organism itself, that the stability of the organism is regained, so that the deviation toward instability has come to be *the cause of its own remedy.* Such regulation is the *avoidance* of those states in the organism or of those conditions in the media which are or have become unfavorable to the stability of the organism, so let us call it *negative regulation.*

Frequent examples of negative regulation are found in the behavior of inorganic manifolds, of plants, and of the lower animals. When a boat in a heavy sea rolls to one side it rights itself into the perpendicular again. It does this because of the fact that the further it tilts from the perpendicular the greater is the leverage by which the pull of gravity, which tends to bring it back, is applied. Its behavior conforms to our definition of negative regulation. The way in which paramœcium retains favorable conditions must be described by the same principle.[2] The valve action at the boundary of the optimum will work for the animal's good in either novel or familiar conditions. A river (organism) shows regulation in migrating from its original channel to one of greater stability, and in overcoming obstacles, such as log jams or landslides, which serve as the cause of their own remedy.

In the above examples correction is *the result* of the excess of process, or deviation from stability. The correction and the condition which needs correction may, however, both be the results of the same cause, having no causal effect on each other. For instance, in crayfish oxygen starvation is corrected by the very activity which causes it, namely, walking. The gills are placed so as to be moved by the legs, for which reason walking causes both depletion and repair of the oxygen content of the blood. Another example is found in the protective color changes in the coat of northern mammals. These changes are possibly not the result of the color environment (the seasonal variation of which is a deviation toward instability), but rather the result of some accompanying condition such as food or temperature plus certain internal factors. That is, the brown fur does not become white because of the whiteness of the snow. The cause to which is due in part the occurrence of the snow, namely, a decrease in temperature, is largely responsible for the adaptive change in the color of the fur. Again, for example, the sunshine which on a summer day would otherwise overheat a man, is in part the cause of the breezes which assist in keeping him cool. The cause, that is, which produces the deviation from the optimum brings about also a condition which helps to restore the optimum.

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[2] Jennings, "Behavior of Lower Organisms."

We may then occasionally find this relation between the deviation from stability and its means of correction. The mutual cause of these two processes may indeed be indefinitely remote. This phase of regulation is not recognized in the above definition, so we may add: *Negative regulation also occurs when a process in the manifold which is the cause of a deviation from stability results independently in its correction.*

POSITIVE REGULATION

An organism may be so constituted that it reacts to some condition which is favorable, adapting itself so as to obtain benefit from it, even when failure so to react to the condition would cause it no more harm than the loss of an unusual benefit. This form of reaction is sometimes given to a condition which the organism does not reach by locomotion, such as a condition which is generally periodic and has no fixed special position (*e. g.*, a weather condition). But if the organism has means of locomotion, the reaction more usually involves a movement toward the favorable condition. This favorable condition may be only occasionally present or it may be only occasionally needed by the organism. The favorable condition to which the organism reacts may be at a distance from, or may impinge upon, the organism. If it is at a distance it must act mediately upon the organism and the organism must have the power of locomotion in order to take advantage of it. The favorable condition may be relatively fixed in space, such as air at the top of the water, or it may be relatively fixed in time, such as the regular recurrence of sunlight. To distinguish this form of regulation let us call it positive.

Positive regulation occurs when some change in the environment or in the physiological state of the organism causes such an adaptive reaction of the organism or such an alteration in the media that the interaction of the newly arranged organism and media which follows brings about increased stability in the organism. In such a process both organisms and media have a double function. The media act first as the stimulus to the organism's adaptive reaction and second as a contributing cause of the increased stability of the organism. The organism likewise must be set or arranged to adjust or orient itself to the changed conditions and also to interact with the novel media so as to cause increased stability in the new relation. The squirrel's storing its food, the butterfly's seeking its mate, and the prospector's digging for gold are all examples of positive regulation.

In positive regulation the favorable condition and the adaptive change do not always have the direct relation of cause and effect. They may be as well results of a single cause. This is especially true in the higher forms of behavior, such as the behavior of a group of sympathetic organisms in a colony or society. For instance, Greek philosophy was a cause which has ramified into many results. Largely because of it, and of the development which it caused, the present-day students write their books on science or philosophy, because of it there are laboratories, without which these books would have lacked much material, and printing presses, without which the volumes would never have reached their readers. That same early philosophy is the inheritance of the people and without it the modern book would not be understood. As another example, when the hot weather in spring impels birds to migrate northward it causes also those changes in the country further north which produce food and the proper conditions for raising the young. So we may add: *Positive regulation occurs when a process in the manifold which is the cause of some potentially favorable condition results independently in an adaptive change by which the organism takes advantage of it.*

Both positive and negative regulation may take place as the result of a change merely in the physiological state of the organism and not be due to any variation in the media. Negative regulation is seen under such conditions in the reactions of the over-fed sea-anemone away from food, or in the behavior of a dog that after a time moves further away from a fire the heat of which had at first attracted him. Positive regulation takes place under like conditions when respiration is increased due to exercise, or when the hungry animal goes out to search for food to which previously it had been indifferent. Judgment and reason in the higher animals furnish the best examples under these conditions for positive regulation. Positive regulation usually results in an increased margin of stability which is insurance against future dangers and permits the organism some rest from the activities of negative regulation. The two forms of regulation are combined in the food reaction of most animals. Hunger results in migratory search after food as well as in its capture. Many animals, however, capture food for future use when the conditions of negative regulation are not present. The two forms of regulation are, for instance, combined when a man rises in the morning partly because he is no longer comfortable in bed and partly because he hears the water running into his tub.

The direct interaction between the conditions existing at any given time as well as the resulting adaptations in the manifold may be described as follows:

In negative regulation unfavorable media (present or at a distance) may cause a change in the organism that makes it either resist such media, or avoid or migrate from such media, or analyze or synthesize such media into innocuous or favorable media. Or some unfavorable part or process in the organism may cause its own elimination or discontinuance, either by interaction with the media, or by action within the organism, or by both of these.

In positive regulation favorable media (present or at a distance) may cause a change in the organism that makes it either interact with such media or enter into or migrate to such media. Or innocuous media (present or at a distance) may cause a change in the organism that makes it analyze or synthesize such media into favorable media. Or some favorable part or process in the organism may cause its own maintenance or continuance, either by interaction with the media or by action within the organism or by both of these.

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THE ANCIENT SPIRIT AND PROFESSOR BABBITT

SOME time ago I had the pleasure of reviewing Professor Babbitt's "Masters of Modern French Criticism" in this JOURNAL;[1] and in a recent issue[2] he has published a courteous reply under the title of "The Modern Spirit and Dr. Spingarn."

Professor Babbitt is much disturbed by my statement that his book lacks "unified and consistent thought" and represents merely "personal bias." I am not certain whether his reply is intended to confirm or refute this statement, since the ideas which he now expresses are exactly those on which I based my original contention. He restates briefly what he had already said in the preface of his book, and I must therefore assume that we are to accept all this as proof of "consistent thought." But consistent thought about what? If he will turn again to my review, he will find this assertion: "The fact is that Professor Babbitt has no esthetic theory. . . . To the questions—What is art? What is literature? What is criticism?—he offers no answers." In his recent reply he does not touch these questions at any point. He explains that literary criticism has much the same problems to face as modern philosophy, that it, too, must deal with the antitheses of intellectualism and intuitionalism, of discipline and anarchy, and so on; and he implies that ideas of this kind vindicate the consistency of his thought in the field of criticism.

I confess, however, that if these utterances are intended as answers to the questions—What is Art? What is criticism?—they are not unlike the answer which my five-year-old son recently gave to

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[1] Vol. X., page 693.

[2] Vol. XI., page 215.